DEFENSE THREAT REDUCTION AGENCY
14.3 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

The mission of the Defense Threat Reduction Agency (DTRA) is to safeguard the United States and its allies from chemical, biological, radiological, nuclear, and high-yield explosive (CBRNE) weapons of mass destruction (WMD) by providing capabilities to reduce, eliminate and counter the threat and mitigate its effects. The activities described herein are drawn from DTRA's basic & applied research, nuclear technologies, counter WMD technologies, and information sciences and applications portfolios. Communications for this program should be directed to:

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The DTRA SBIR Program complements the agency's principal technology programs to detect, locate, and track WMD; interdict or neutralize adversary WMD capabilities; protect against and restore capabilities following WMD use; attribute parties responsible for WMD attacks; and provide situational awareness and decision support to key leaders. SBIR topics reflect the current strategic priorities where small businesses are believed to have capabilities to address challenging technical issues. DTRA supports efforts to advance manufacturing technology through SBIR, where the challenges of such technology are inherent to technical issues of interest to the agency.

PROPOSAL PREPARATION AND SUBMISSION

The SBIR Program Solicitation (found at http://www.dodsbir.net/solicitation/) provides the proposal preparation instructions. For DTRA Phase I, consideration is limited to those proposals which do not exceed $150,000 and seven months of performance. Proposals may define and address a subset of the overall topic scope. Proposals applicable to more than one DTRA topic must be submitted under each topic. Please note that the solicitation has been extensively rewritten and should be read carefully prior to proposal submission.

PHASE I PROPOSAL REVIEW AND EVALUATION

During the proposal review process, employees from BRTRC, Inc., and TASC, Inc. will provide administrative support for proposal handling and will have access to proposal information on an administrative basis only. Organizational conflict of interest provisions apply to these entities and their contracts include specifications for non-disclosure of proprietary information. All proposers to DTRA topics consent to the disclosure of their information to BRTRC, LEIDOS, SUNTIVA and TASC employees under these conditions.

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The Technical Point of Contact (TPOC) leads the evaluation process of all proposals submitted in their topics. DTRA will make a determination as to whether the proposal is relevant to the topic solicited. Only relevant topics will be evaluated against further criteria. DTRA will evaluate Phase I proposals using the criteria specified in section 6.0 of the DoD SBIR Program Solicitation during the review and evaluation process. The criteria will be in descending order of importance with technical merit being the most important, followed by qualifications, and followed by the commercialization potential. With other factors being equal, cost of the proposal may be included in the evaluation. DTRA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. However, a DTRA SBIR goal is to provide awards in each Phase I topic solicited.

CONTINUATION TO PHASE II

Small business concerns awarded a Phase I contract will be permitted to submit a Phase II proposal for evaluation and potential award selection. The Phase II proposals must be submitted NLT 30 days BEFORE the end of the Phase I effort.

All SBIR Phase II awards made on topics from solicitations prior to FY 13 will be conducted in accordance with the procedures specified in those solicitations.

DTRA is not responsible for any money expended by the proposer prior to contract award.

Phase II review and evaluation will be similar to the Phase I process. The TPOC leads the evaluation process of all proposals submitted in their topic areas. The Phase II proposal evaluations will use the criteria specified in section 8.0 of the DoD SBIR Program Solicitation for the review and evaluation process. The criteria will be in descending order of importance with technical merit being the most important, followed by contractor's qualifications, and followed by the commercialization potential. With other factors being equal, cost of the proposal may be included in the evaluation. DTRA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

DECISION AND NOTIFICATION

DTRA has a single Evaluation Authority (EA) for all proposals received under this solicitation. The EA either selects or rejects Phase I and Phase II proposals based upon the results of the review and evaluation process plus other considerations including limitation of funds, and investment balance across all the DTRA topics in the solicitation. To provide this balance, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Following the EA decision, DTRA SBIR will release notification e-mails for each accepted or rejected offer. E-mails will be sent to the addresses provided for the Principal Investigator and Corporate Official. Offerors may request a debriefing of the evaluation of their not selected proposal and should submit this request via email to dtrasbir@dtra.mil and include "SBIR 14.3 Topic XX Debriefing Request" in the subject line. Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the EA decision.

For selected offers, DTRA will initiate contracting actions which, if successfully completed, will result in contract award. DTRA Phase I awards are issued as fixed-price purchase orders with a maximum period of performance of seven-months. DTRA may complete Phase I awards without additional negotiations by the contracting officer or opportunity for revision for proposals that are reasonable and complete.

DTRA manages SBIR as an ongoing program and does not classify individual Phase I awards as new program starts for the purpose of Continuing Resolution Authority.

OTHER CONSIDERATIONS

DTRA does not utilize a Phase II Enhancement process. While funds have not specifically been set aside for bridge funding between Phase I and Phase II, the potential offeror is advised to read carefully the conditions set out in this solicitation.

E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DTRA SBIR 14.3 Topic Index

DTRA SBIR 14.3 Topic Descriptions

DTRA143-001 TITLE: Smart Materials To Indicate Personnel Presence In Proximity To Containers

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: Identify and develop a smart material with properties suitable for application in a sensor system to detect and store information that supports awareness of the presence of personnel in the immediate vicinity of containers or other points of interest.

DESCRIPTION: Cameras, infrared sensors, other passive detectors, and visual inspection by guard forces are examples of current means to detect the presence of personnel around containers, stored items, and other secured areas of interest. These methods serve monitoring needs in well-patrolled grounds or for items under careful control, but do not address a more general need to monitor or control activity 24/7 in locations where there may not be a robust guard force readily available for on-site observation or immediate action in response to an observed signal from a sensor. The focus of this effort is not a sensor system to look inside containers; nor is this solicitation aimed at change detection algorithms for video monitoring. Rather, a material is sought that will yield an easily observable physical change indicative of how frequently a site is visited and for how long on each occasion. Possible applications include monitoring and verification of compliance with the treaties that in the future could include terms anticipating the availability of sensor systems based on these smart materials. Such smart materials sensors would enable on-site or remote interrogation (and may be compatible with lab analysis of retrieved materials if additional assurance is of interest), enhancing transparency and assurance and increasing trust.

Materials that exhibit response to two or more signatures are sought to assure detection and minimize false positives. Signatures that may be considered include those that are inherent to the human body, or artifacts generated from human activity, such as motion or acoustic signals. For example, humans generate up to ~100 Watts of heat, but temperature sensing alone may not be sufficient given competing background. Similarly, humans emit molecules through breath including volatile compounds that could be detected at meters or greater range. Sensing of trace molecules emanating from human breath may demand sensitivity of parts-per-million or billion, however.

An objective is to demonstrate that the multi-signature smart material could be incorporated into a small form factor sensing device. Therefore, the ideal outcome would be a smart material fabricated as a “smart tab”, preferably planar, <100 cm2 in size and sufficiently lightweight as to enable affixing to a vertical or horizontal surface with an appropriate adhesive or mounting fixture. Flexible materials capable of being adhered in a conformal fashion to more general surfaces are desirable but flexibility is not essential. Material response to signatures should be stored and easily read, by visual inspection (e.g., passive color response, surface shape change) or other simple means that may be available to an inspector. The material response need not be reversible, provided there is a means to recognize multiple events over time. Interface of the material to an interrogation means for real-time or near-real-time data transmission to a remote receiver is also desirable, but schemes that perform forensic analysis on stored data are also acceptable. Selection of signatures should aim to minimize false positives. Ideally, the material response should be compatible with data analysis means that will allow interpretation of the characteristics of the signals to determine the number of humans present and the time periods during which they were present. It is also necessary that the material and any power sources needed enable long-dwell applications of at least 30 days.

PHASE I: Conduct an exploratory study to compare signatures and evaluate combinations desirable to provide proof-of-concept of a smart material indicator of human presence. 1) The selection criteria for the number and types of signatures include generation of sufficient signal-to-noise to estimate the number of individuals present within a 10 m range for time periods of less than minute. Shorter durations/greater range are favored. The smart material tab should be robust in an indoor environment and capable of functioning for 30 days unattended. 2) Development of a project plan for fabrication and testing of the sensor devices based on the smart material. The test plan shall avoid experimentation with human subjects by using surrogate signatures. (3) Identify appropriate interrogation means and data storage and transmission methods for the use case of an inspector at a weapons storage facility charged with determining how many people came within 10 m of the site and when over a 30-day period.

PHASE II: Develop a prototype sensor that integrates multiple sensing functions into a smart material tab. 1) Develop specific material tabs for testing with surrogates for human signatures, specifically addressing shielding issues such as saturation of signatures by large crowds, and other means by which the presence of individuals may be masked, and the ability to record information that includes how many were present at what time. 2) Provide insight into the scope of parameters about individuals and groups that may be gathered by these tabs, and tailor the material structure to optimize detection of patterns of interest. 3) Identify appropriate manufacturing, scale-up, methods to affix detectors to assets to be monitored, appropriate interrogation, data storage, data transmission or passive read-out methods, and data analysis methods (preferably COTS products) and cost estimate, in order to support potential for transition to a counter-WMD program.

PHASE III: Once utility for DOD applications has been established, identify and exploit additional features that would be attractive for marketing a smart material-based sensor system for commercial or other private sector applications such as civilian law enforcement, corporate security, search and rescue, mass transit, and crowd monitoring. Such features may include robustness for outdoor use, development of arrayed systems, or means to integrate the smart materials sensor system with other commercially used systems. Distributed sensor configurations with multiple data communication modalities, including wireless, can provide added value. Teaming with security technology companies would expand identification of markets.

REFERENCES:
(1) Bock, K., "Materials for Electronics and Microsystems Technologies", European Parliament workshop, Brussels, Belgium, 10 July 2012:
http://www.europarl.europa.eu/stoa/webdav/site/cms/shared/2_events/workshops/2012/20120710/Karlheinz%20Bock.pdf

(2) Risby, T., "Breath Analysis Overview", MIRIFISENS Workshop, January 14, 2014, Zurich, Switzerland:
http://www.mirifisens-project.eu/sites/default/files/mirifisens_images/Risby%20MIR%20Talk.pdf

(3) Teixeira, T., Dublon, G., Savvides, A.,"A Survey of Human Sensing: Methods for Detecting Presence, Count, Location, Track, and Identify": http://www.eng.yale.edu/enalab/publications/human_sensing_enalabWIP.pdf

(4) Damarla, T., Kaplan, L., Chan, A., "Human Infrastructure & Human Activity Detection", U.S. Army Research Laboratory, 10th International Conference on Information Fusion, 9-12 July 2007, Quebec, Canada:
http://www.dtic.mil/dtic/tr/fulltext/u2/a520768.pdf

(5) Bornstein, A. et. al., "Remote Detection of Covert Tactical Adversarial Intent of Individuals in Asymmetric Operations", U.S. Army Research Laboratory, ARL-SR-197, April 2010:
http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA522207

(6) R&D Magazine, "Tiny, wireless sensing device remotely alerts users to tell-tale vapors":
http://www.rdmag.com/news/2014/04/tiny-wireless-sensing-device-remotely-alerts-users-tell-tale-vapors?et_cid=3865428&et_rid=520459550&location=top

KEYWORDS: smart material, detection, monitoring, storage, control, identification

DTRA143-002 TITLE: Production of Chemical Reagents for Prompt-Agent-Defeat Weapons

TECHNOLOGY AREAS: Chemical/Bio Defense, Materials/Processes

OBJECTIVE: The objectives of this effort are to: 1) develop the necessary manufacturing processes to produce kilogram quantities of novel halogen-containing chemical reagents, and 2) to apply these processes to manufacture several kilograms of these reagents. These novel chemical reagents have been previously researched for use to reliably destroy biological-agent targets that could pose a threat to global security.

DESCRIPTION: The Defense Threat Reduction Agency's Basic Research Program, Thrust Area 4 – Science to Defeat WMD (weapons of mass destruction), has been supporting research of energetic materials and incendiaries as payloads for weapons to defeat targets containing chemical and biological agents. Several universities and Navy labs have been involved in this research, and have narrowed down on a few material formulations that are efficient biocides. These formulations contain a chemical ingredient HI3O8, which is currently commercially obtained as HIO3 and processed at gram-scales in a Navy lab. While the process path is not complicated, larger-scale production at a Navy lab is not cost beneficial nor process efficient for larger scale needs. Therefore, we are seeking to scale-up processing to inexpensively produce HI3O8 to support larger-scale testing and evaluation of future agent-defeat weapons. The success of this work will result in capabilities to deny enemy use of bio-agents while mitigating the associated collateral damage and effects of an infectious downwind plume.

PHASE I: 1) Develop cost-beneficial manufacturing processes for producing kilogram quantities of HI3O8 with high purity (99.5%) and small particle size (about 2 microns). 2) Produce 500 to 1000 grams quantities of HI3O8 as needed for test articles. 3) Ship material for performance testing.

PHASE II: Based on the quality of HI3O8 produced in Phase I, the cost/benefits of HI3O8 production, the likelihood of successfully scaling up to kg amounts, and the performance of the material formulations for bio-agent defeat; DTRA will decide a path forward for Phase II. Phase II work will be to produce larger scale quantities (5 to 20 kilogram) of HI3O8 with the same purity and particle size standards described in the Phase I effort. Material produced in Phase II will be used for larger scale testing. Development of a commercialization strategy should also be achieved in Phase II.

PHASE III: DUAL USE APPLICATIONS: HI3O8 is a dual use chemical that has potential to be used not only in WMD-defeat weapons but also in propellant systems.

REFERENCES:
1. Defense Threat Reduction Agency Broad Agency Announcement HDTRA1-08-10-BRCWMD-Service Call, Topic Per5-H: Bio-Agent Defeat (Thrust 4), June 2010, http://www.dtra.mil/documents/research/BRCALL08-10.pdf.

2. Efficacy of Energetic Formulations in the Defeat of Bio Agents, https://www.combustioninstitute.org/upload_resources/12S-86.pdf

3. Thermobaric materials and devices for chemical/biological agent defeat, US 8118955 B2, April 2007, http://www.google.com/patents/US8118955.

KEYWORDS: chemicals, chemical processing, chemical production, iodine

DTRA143-003 TITLE: Plume Diagnostics/Source Term Development for C-WMD Agent Defeat Testing Accuracy

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics

OBJECTIVE: To provide innovative technologies and next generation C-WMD system weapon-effects testing components/methodologies to validate effective C-WMD testing. Develop next generation plume diagnostics/modeling/source term development for effective sampling and analysis of C-WMD offensive weapons development. The ability to detect, quantify, track, and validate chemical/biological simulant and agent characteristics during multiple stages of energetic plume development (source term) seeks innovative next generation solutions from small business research & development.

DESCRIPTION: The ability to detect, quantify, track, model, and validate chemical/biological simulants and agent characteristics during multiple complex stages of energetic plume development (source term) currently lacks effective next generation technologies to address this critical aspect of C-WMD offensive weapons development. Small business innovation research efforts have shown great strides in providing robust, innovative technologies with high commercialization potential to address this specific shortfall. C-WMD offensive weapons testing and advanced modeling engines require accurate, precise, rugged/survivable, and timely chemical/biological plume and concentration measurements in a harsh, chaotic, energetically charged environment with respect to explosive plume morphology. In order for the U.S. to hold the use of WMD weapons at risk, it must seek next generation test validation equipment and methods to reinforce precision offensive strike phenomenology with respect to illicit

WMD storage and production facilities. A strategic investment area in C-WMD is the ability to neutralize illicit production, storage, and use of WMD. In order to safeguard this strategic investment area, it is essential that offensive weapons minimize collateral damage effects associated with the energetic release/dispersion of collateral WMD products during all stages of energetic strike. C-WMD testing currently lacks absolute testing validation and confirmation for effective stand-off detection/quantification technologies for prompt and near field plume chemical/biological agent analysis. Next generation innovative solutions are required to collect and validate energetic weapons test data to ensure minimum collateral damage and derivation of source term data that will feed modeling and development of C-WMD offensive weapons.

Plume Diagnostics for Energetic WMD Release must eventually consider all stages of the plumes life. A representative diagnostic approach is represented below:
Representative Scenario: Ability to detect and quantify chemical/biological simulant and agent release during different stages of a plumes development/mortality. Current technologies are challenged with the proper analysis of prompt or near-field plume measurements of any degree of accuracy. Spectroscopic methods are hampered by light scattering of particular matter and point source methods with blast damage. Innovative technologies developed should allow for robust, repeatable, accurate, precise, specific/sensitive, and timely report of chemical/biological concentration measurements in energetic plume.

STAGE I: Prompt Plume (Source Term)
Characteristics: Fireball, rapid expansion, overpressure wave, high temperature, debris, 0-several hundred ft. AGL (Above Ground Level).
- Time scale: 0-100 ms (millisecond, estimated)
- Desired measurements: simulant/agent concentration (parts-per-billion, low ppb-%), temperature, pressure
- Frequency: conc. 10 KHz (Kilohertz, 10 data point/ms) at multiple sampling points

STAGE II: Near-Field Plume
Characteristics: Diminishing fireball, rapidly expanding plume, debris, cooling plume, diminishing pressure. 0-2000 ft. AGL.
- Time scale: 101 ms-2 min
- Desired measurements: simulant/agent concentration (low ppb-%), temperature, pressure
- Frequency: conc. 1 KHz (1 data point/ms) at multiple sampling points

STAGE III: Post Near-Field Plume
Characteristics: No fireball, limited expansion, drifting/dispersing with winds, cooled, approximately 2000 ft.
- Time scale: Greater than 2 minutes
- Desired measurements: simulant/agent concentration (parts-per-million, ppb-ppm), temperature, pressure
- Frequency: Conc. 1 data point every 1-2 sec. going to 1 data point/min at multiple sampling points

PHASE I: Provide documentation that identifies one or more novel, innovative energetic energy measurement approaches that allows for accurate, precise, repeatable chemical/biological agent and simulant concentration measurements in a clean (no particulate explosion) and in an explosive, energetic release environment with various particulate contamination representative of normal building materials (wood, clay, concrete, tire) using next generation innovative technology solutions. Candidate technologies should address the following characteristics (not in order of priority):
- High Collection Efficiency (Capture Devices)
- Literature that is amenable to exploitation is encouraged
- Simple Demonstration or Proof-of-Concept on technological approach. The technological approach should be able to demonstrate a linear working range or confidence in achieving this linear range that spans the expected range of chem/bio agent/simulant concentrations. Show repeatability or confidence (literature or simple demo, $R2 \geq 0.90$; $\%RSD \leq 10\%$, LOQ= ppb-ppm range).
- Environmental constraints such as temperature, humidity, vibration limitations, or other
- Ease of use/integration with existing energetic test instrumentation currently available on the market or in use
- Identify technology readiness level (TRL), manufacturing costs for production, and commercialization potential
- Identify clear path for Phase II consideration (TRL progression potential)

PHASE II: Develop complete engineering designs and demonstrate a prototype innovative energetic energy measurement approaches that allows for accurate, precise, repeatable chemical/biological agent and simulant

concentration measurements in an energetic test release environment. The energetic release environment should include all particulate material considerations that are representative of an illicit WMD production/storage facility. Further exploitation of select Phase I innovative technology route should include and not limited to:
• Increased TRL Level 4 with demonstrated and verifiable small scale testing venue. The field prototype instrument(s) will be capable of operations in a sub-scale testing environment (10%-50% of a full scale test). The prototype should be able to demonstrate a linear working range that spans the expected range of chem/bio agent/simulant concentrations, be repeatable through a series of explosive events, validated (i.e., initial calibration models be challenged by follow on tests exhibiting variable chem/bio agent concentrations over different particulate loading environments), and exhibit acceptable analytical figures of merit for a prototype effort ($R2 \geq 0.99$; $\%RSD \leq 10\%$, LOQ= ppb-ppm range).
• Identify potential partners for production and commercialization of the product.
• Identify clear path to Phase III considerations with roadmap
• Manufacturing Costs

PHASE III: DUAL USE APPLICATIONS: Produce low-rate production quantities for military and commercial markets. Potential commercial applications include industrial chemical and biological engineering and test distributed sensor networks for environmental monitoring such as: petroleum, industrial energetic production, and security applications that monitor explosive plume intrusions/threats. Homeland Security, environmental air quality, and analytical chemistry/control process applications are in need of innovative CWMD detection/monitoring equipment that has demonstrated capability of surviving chaotic high energy/high temp environments.

REFERENCES:
1. M.S. Reisch, Chem and Engr. News, 91(34), 11-15 (2013).

2. B. Boyle, “Ion Mobility Mass Spectrometry-The Next Five Years”, www.owlstonenanotech.com(2013).

3. M.E. Klein, B.J. Aalderink, R. Padoan, G. de Bruin, T.A.G. Steemers, Sensors, 8, 5576-5618 (2008).

4. R. L. N. Yatavelli et al., Aerosol Science and Technology, 46:1313–1327, 2012).

KEYWORDS: Plume, WMD Defeat, precision, accuracy, instrumentation, chemical analysis, biological analysis, remote sensing, standoff detection.

DTRA143-004 TITLE: Novel Munition Technologies to Attack and Defeat Weapons of Mass Destruction (WMD)

TECHNOLOGY AREAS: Battlespace, Weapons

OBJECTIVE: To identify and develop new innovative technologies that can be employed to offensively attack and defeat WMD materials, equipment, processes, and operations while dramatically mitigating, and potentially negating, collateral contamination effects from the release of airborne hazardous materials.

DESCRIPTION: Current offensive weapons rely on blast, overpressure and fragmentation as their primary mechanism to defeat targets including those containing WMD materials such as chemical and biological warfare (CBW) agents. Unfortunately, these same mechanisms can create large and unacceptable consequences through the release of toxic materials as downwind airborne hazards. Research of WMD defeat payloads have typically focused on the integration of thermal or reactive formulations with traditional high explosive fills to neutralize CBW airborne agents inside target structures prior to venting. However, the risk still remains that active CBW agent can be forcibly released from a targeted structure, especially if the confining structure is destroyed from weapon blast and overpressure effects. Additionally, explosively produced CBW agent source terms and plumes are extremely challenging to measure accurately due to their size and altitude and sensor survivability issues, limiting confidence in weapon performance. Unique technologies are needed that can drastically reduce CBW agent release (mass, volume, energy), with a desire to negate such releases, while imparting effects that can deny use of WMD materials and equipment.

These types of technological solutions and capabilities are envisioned to have zero to minimal amounts of high explosives that results in near-zero blast and overpressures thus minimizing the dynamic forces that can damage confining facility structures and expel toxic CBW agents. Denial effects can range from preventing removal or use of WMD materials and equipment. Denial effects can be a matter of days (threshold) to a matter of weeks (objective). Acceptable defeat mechanisms include lethal or non-lethal effects, energetic or non-energetic payloads, and can hold at risk most WMD activities such as production, storage, and delivery.

The purpose of this SBIR solicitation is to identify and develop new and innovative technologies that can be employed in stand-off situations to address the aforementioned need. Solutions should be easily integrated into existing delivery systems (e.g., aircraft, missiles, etc.), safe to store and handle, and not violate any existing domestic and international laws, policies, or treaties. Additionally, proposed solutions must be capable of demonstrating their performance with a sufficient level of accuracy and confidence. The proposed technology or concept can use kinetic or non-kinetic and active or passive means to achieve effects on WMD targets. Currently, no commercial, applied defense system, or mature CONOPS exists to completely meet this need.

PHASE I: The offeror shall identify and describe an innovative technology or set of technologies that satisfies the above capability needs with near-zero blast and low overpressures. Additionally, the offeror must produce a concept(s) of employment (CONEMP) for the proposed technology, and proposed metrics for evaluation. The technology concept design shall include empirical or analytical data to validate the underlying assumptions of its performance. The Phase I final report must clearly describe the Phase I to Phase II transition and key decision points along with a roadmap of key events through the planned Phase III.

PHASE II: The offeror will acquire and build a prototype technology concept(s), demonstrating it at a bench-top or sub-scale level against representative CBW materials, equipment, processes, and/or operations used in production and storage facilities. The final report must demonstrate how this concept could be integrated into a weapon system with a complete discussion of the design tradeoffs required to make this a viable system for field use. Potential partners for development, testing, and future use of the developed technology along with a clear Phase II to Phase III decision point must be included along with an updated roadmap that takes the program through the end Phase III.

PHASE III: The offeror will optimize the prototype concept and demonstrate it at the full scale level against a representative CBW production and/or storage facility.

PHASE III DUAL USE APPLICATIONS: WMD defeat technologies can prove useful for related military combating WMD activities such as elimination and interdiction missions, homeland security, anti-terrorism, and law enforcement situations. Additionally, capabilities developed by this SBIR, in part or as a whole, may have other conventional military applications against non-WMD targets. Depending on the capability or capabilities developed, components or sub-systems may also be employed in non-military applications such as counter-drug missions.

REFERENCES:
1) Joint Publication 3-40, Combatting Weapons of Mass Destruction, Joint Staff, 10 June 2009

2) TRADOC Pamphlet 525-7-19, The United States Army Concept Capability Plan for Combating Weapons of Mass Destruction for the Future Modular Force 2015-2024, 25 March 2009

3) National Military Strategy of the United States of America, Joint Staff, 8 February 2011

4) Sustaining U.S. Global Leadership: Priorities for 21st Century Defense, Department of Defense, January 2012

KEYWORDS: Combatting WMD, WMD Defeat, Agent Defeat, weapons, munitions, weapons of mass destruction

DTRA143-005 TITLE: <u>Knowledge Base Population and Reasoning</u>

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Design approach to building a comprehensive knowledge store supporting cross program knowledge sharing and discovery.

DESCRIPTION: DTRA has the challenge of identifying key information from review of a very large collection of streaming data feeds, whose volume continues to grow over time. A large component of the data is documents, many of them multi-page and multi-part, written in a variety of prose styles. Using automated extraction, such as that provided by Natural Language Processing (NLP), DTRA is able to identify information that over time will accumulate more related data and more relevance – if it can be represented in such a way that the analyst can effectively search this knowledge base and find the critical information from an enormous collection of related data (Figure 1).

Figure 1: Expertise applied to extracted facts becomes knowledge used in analytical products.

Currently, state of the art knowledge representation systems perform knowledge acquisition by translating English into classic logical statements, often in first order logic. Varied prose styles and document types decrease the extraction accuracy to the point it is insufficient to solve DTRA needs to sift through a very large, constantly growing store of knowledge for important insights. In addition, sources can provide conflicting knowledge, which is very difficult for current systems to represent and make searchable, yet which often contains the critical relationships the analyst needs to retrieve. DTRA therefore requires research in the area of Knowledge Representation and Reasoning, along with associated natural language querying technology, in order to determine the optimal choice to store growing new knowledge discovered daily through natural language processing algorithms.

Recent advances, such as RuleLog (knowledge-based tool) and associated tools, improve on these systems with support for multiple contexts, which recognize the defeasible nature of knowledge, and improved tractability through improvements adopted from the database and the semantic web communities. DTRA is interested in research in the area of knowledge representation and reasoning systems that can support the following requirements: (a) rapid knowledge base population from existing Resource Description Framework (RDF) stores with support for streaming new assertions; (b) support multiple contexts and recognition of the exceptional and defeasible nature of knowledge; (c) provide a highly tractable data store with support for fast natural language query answering; (d) enable rich representation of knowledge underlying a strong reasoning system which can provide why-not answers as necessary; and (e) work with existing Object Web Ontology Language (OWL) ontologies to initialize the knowledge base. Such a knowledge base could form the basis for a DTRA-wide effort to build and store knowledge in a comprehensive and compatible way that would support cross program knowledge sharing and discovery as and where appropriate.

PHASE I: Research and develop methodologies to create elements of knowledge that can be stored in a knowledge base. The knowledge base must be searchable for individual units based on keywords, but also identify relationships with other knowledge elements that would not be identified from a keyword search. Demonstrate knowledge base population from existing triple stores and new documents. At the conclusion of Phase I, produce a conceptual architecture design identifying necessary hardware and software to create a knowledge base system and technology gaps that must be resolved prior to building a system.

PHASE II: Develop, demonstrate, and validate a prototype system based on the preliminary design from Phase I. All appropriate engineering testing will be performed, and a critical design review will be performed to finalize the design. The Phase II deliverable will include a working prototype of the software, specification for its development, and demonstration of knowledge base querying.

PHASE III: Optimize the prototype system and demonstrate it at the full scale level, capable of ingestion of 1000+ new knowledge elements per day. This technology will have broad application in military, government, and commercial settings. Within the military and government, there is an increasing emphasis on technologies that aid decision-makers while managing big data. Developing tools that can rapidly integrate information and provide a process for analyzing data to compliment a user's decision making process will be a powerful addition to strategic, operational, and tactical decision making.

REFERENCES:
1) Nonmonotonic Reasoning in FLORA-2, M Kifer - Logic Programming and Nonmonotonic Reasoning, 2005

2) Electric elves: Applying agent technology to support human organizations, H Chalupsky, Y Gil, C A Knoblock, K Lerman, J Oh, D V Pynadath, T A Russ,M Tambe - Proceedings of the 13th International Conference of Innovative Application of Artificial Intelligence (IAAI-2001, 2001)

3) OntoMorph: a translation system for symbolic knowledge, H Chalupsky - in Proc. of the Seventh International Conference on Principles of Knowledge Representation and Reasoning, 2000

4) CYC: A large scale investment in knowledge infrastructure, Douglas Lenat - Communications of the ACM, 1993

5) Rapid Text-based Authoring of Defeasible Higher-Order Logic Formulas, via Textual Logic and Rulelog (Summary of Invited Talk), Benjamin N. Grosof, 2013

6) Figure 1: Expertise Applied to Extracted Facts Becomes Knowledge Used in Analytical Products, Flow Chart, 1 page, uploaded in SITIS 08/25/2014.

7) Additional Q&A from TPOC, uploaded in SITIS 9/24/14.

KEYWORDS: Combating WMD, WMD Defeat, Knowledge Base, Natural Language Query, Natural Language Processing, NLP

DTRA143-007 TITLE: Advanced Fast Shutter for Debris Mitigation

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Electronics, Battlespace, Space Platforms, Nuclear Technology

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.3 of the solicitation.

OBJECTIVE: Develop a fast valve/shutter debris mitigation system that can close an open aperture to protect a test object of at least 3 cm diameter from debris moving at ~20 km/s. The application is to block particulate and plasma debris from cold x-ray and extreme ultra-violet (EUV) radiation sources during testing of optical components.

DESCRIPTION: Advanced debris mitigation systems are needed to enable the testing of sensitive optics and surface coatings for extreme ultraviolet and cold x-ray nuclear weapon effects (NWE) responses to certify the survivability and operability of mission critical DoD systems that must operate in exoatmospheric nuclear burst environments. This requires exposures to pulsed radiation sources with photon energies of 50 eV to >1 keV (EUV/cold x-ray regime).   The radiation sources used to conduct NWE tests generate plasma, gas and particulate debris that can cause more damage to the test objects than the radiation. The pulsed EUV/cold x-ray sources used for NWE testing are typically Plasma Radiation Sources (PRS) from electromagnetic Z-pinches driven by millions of Amperes. The pinch sources are typically ~4 cm in length and produce high velocity (>20 km/s) plasma and particulate debris that must be prevented from reaching the test object. There are also Laser-Driven Plasma Radiation Sources (LDPRS) that produce less particulate debris, but may produce even faster plasma debris. Because of the need to minimize the attenuation of the photons in the 50-1000 eV range, it is difficult to use solid density films to slow the debris. However, helium gas puffs have been shown to be effective at retarding plasma debris from EUV sources[1] and it may be possible to use x-ray driven blow-off to inject material into the beam path to slow source debris after the x-rays have passed. Slowing the fastest debris may be needed to enable a mechanical fast valve/shutter system to have time to protect a test object more than 20 to 200 cm from the source. The full debris mitigation system may require multiple stages to slow plasma debris, stop particulates, and finally form a vacuum seal to prevent gas contamination.

PHASE I: Produce a conceptual design and potentially a small scale prototype for an innovative fast valve/shutter system that can be used to protect a test object of at least 3 cm diameter. The debris mitigation system should support shot rates of at 4 shots per 8-hour shift. The system should be triggerable with a jitter time of less than 100 ns to the beginning of valve/shutter closure.

PHASE II: The Phase II demonstration should fabricate the complete debris mitigation system prototype for fielding on a plasma required radiation source at the DTRA-owned Double-EAGLE simulator in San Leandro, CA. Test time on the machine will be provided by DTRA. The contractor is encouraged to partner with the facility operators to plan and execute the demonstration. The Phase II effort should use coated optics as witness plates to confirm EUV/x-ray exposures and to demonstrate a debris-free environment. Upon successful concept demonstration, the Phase II effort should include the design of a final debris mitigation system that will meet or exceed the goals and should be transferrable to other x-ray test facilities. The final report should include estimates of the cost to conduct a shot and the shot rates that could be achieved.

PHASE III: The way ahead for the application of the innovative design to DoD applications may include coordinating with a DoD, NNSA, or other facility operator to design, fabricate, and field advanced warm x-ray sources to support NWE testing funded by defense program customers. Defense programs that may be interested in using the advanced test capability include: the Missile Defense Agency; Space and Missile System Center satellite programs; and Air Force and Navy strategic systems sustainment and life extension programs.

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[1] M. Watanabe, N. Kishi, N. Iizuka, T. Orishimo, J. Fei, A. Okino, E. Hotta, "Optical Observation of Gas Jet Z-Pinch Discharge Produced Extreme Ultraviolet Light Source", page 1679-1682, in Proceedings of the 16th IEEE Pulsed Power Conference, Albuquerque, NM, 2007, edited by Edl Schamiloglu and Frank Peterkin, (IEEE, Piscataway, NJ, 2009), IEEE #978-1-4244-4065-8/09.

[2] D.K. Abe, J. Golden, T.G. Johnson and R. Schneider, "The Design and Operation of a Compact, Ultra-Fast Closing Valve For Debris Mitigation" in Proceedings of the 9th IEEE International Pulsed Power Conference, Albuquerque, NM, 1993, edited by K. Prestwich and W. Baker (IEEE, Piscataway, NJ, 2009), p. 170, IEEE #978-1-4244-4065-8/09.

[3] D. C. Rovang, W. W. Simpson, L. E. Ruggles, and J. L. Porter, "An Electromagnetic Fast Shutter System For Debris Mitigation On Z*", page 1012-1015, in Proceedings of the 13th IEEE Pulsed Power Conference, Las Vegas, NV, 2001, edited by Bob Reinovsky and Mark Newton, (IEEE, Piscataway, NJ, 2009), IEEE #0-7803-7120-8/02.

KEYWORDS: Debris mitigation, fast valve, NWE testing, pulsed power, cold x-ray, Plasma Radiation Source

DTRA143-008 TITLE: Lithography Cost Reduction for Rad Hard Integrated Circuits

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The primary objective of this effort is to support the introduction and use of gridded 1D photomask design (Ref 1) or direct write technologies e-beam direct write (EBDW Ref 2) technologies for enhanced security and reduced production costs of critical ASICs at Trusted foundries. Either 1D Gridded Lithography or e-beam direct write or a combination of the two is acceptable.

DESCRIPTION: The US Senate Report 113-044 (National Defense Authorization Act for Fiscal Year 2014 Report) identifies Trusted microelectronics as items of special interests. The committee urges DoD to ensure that an enterprise-wide approach to microelectronics trust is taken, to include the security of photomask design and manufacturing tools given their criticality in the integrated circuit manufacturing process.

Of particular interest to this solicitation are new and innovative manufacturing technologies to enhance security of photomask design and inspections tools for manufacturing of Rad Hard integrated circuits at reduced production costs. These include, but are not limited to development of gridded 1D design or e-Beam direct write technologies EBDW. Development of the manufacturing technologies will support the use of submicron ultra-deep, radiation-hardened integrated circuits for critical DoD applications.

PHASE I: Demonstrate a proof of concept of gridded 1D design or direct write technologies EBDW to enhance the security of photomask design. Provide a plan for further development and demonstration of the technology in Phase II. A clear roadmap outlining program development through Phase III and that describes the Phase II to Phase III decision point must also be part of the final delivery for Phase I. Identification of dual use commercial applications is also desirable.

PHASE II: Demonstrate the technology to develop a 1) gridded 1D design methodology or gridded direct write EBDW technologies and develop a path to a 2) demonstrate 1D Lithography or EBDW with resolution to produce <22nm FinFETs. Identify and address technological hurdles. Industry and government partners for Phase III must be identified along with demonstration of their support. A revised roadmap that takes the program through Phase III must be part of the final delivery for Phase II.

PHASE III: The end state of this effort is a technology to support the use in defense systems of radiation-hardened integrated SOC with the use of gridded 1D design and gridded direct write EBDW technologies.

PHASE III DUAL USE APPLICATIONS: These technologies are required for a rapid and cost effective ASIC design flow at advanced technology nodes in the Defense and Commercial sectors. Significant dual use and improvements in weight, power and reliability for satellite systems are also anticipated to result from development of the technologies. These technologies also provide a cost effective path to translate electrical designs from untrusted foreign FPGAs to trusted domestic ASICs for use in a broad range of applications that extend from high performance microprocessors and low power advanced servers.

REFERENCES:
1. M. Smayling, Proc. of SPIE Vol. 8880 888012, pp 1-7, 2013

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3. C. Jan et al, IEDM 2012 Tech Dig., pp 44-47, 2012

4. R. Brain et al, Sym. VLSI Tech. Dig. of Tech. Papers, pp T16-17, 2013

KEYWORDS: Materials/Processes, Nano-technology, Nuclear Technologies, Single-Event Effect, Total Ionization Dose, Radiation Hardened Microelectronics

DTRA143-009 TITLE: Post-detonation Debris Analysis for the Advancement of the Nuclear Forensics Timeline

TECHNOLOGY AREAS: Nuclear Technology

OBJECTIVE: Enable real-time analysis of post detonation debris with in-field deployable systems to provide analytical information about the nuclear yield detonation event to enable nuclear forensic assessments.

DESCRIPTION: The United States Government (USG) has identified nuclear forensics as a vital national security priority. In the event of a nuclear detonation, there will be an urgent national requirement to determine the nature and origin of the weapon used and those responsible for the attack. The attribution of a nuclear event will rely on information from nuclear forensics, law enforcement investigation, and other channels. The first step in the nuclear forensics process after a detonation is to quickly collect samples near the detonation site and quickly analyze them whether in-situ or at designated laboratories.

Potential in-field systems are intended to identify, and quantify to the extent possible, the nuclear materials and other identifying signatures used in the detonation event. Solid debris samples to be analyzed are expected to contain trace-level quantities of nuclear device debris combined with material from the immediate detonation environment that may have been activated and is assumed to have been vaporized and recondensed. As such, debris for dissolution is expected to have formed at high temperatures and contain silicates and other hard-to-dissolve materials. Solid samples may be collected while dispersed in the air or after they have settled to the ground.

Gaseous samples are also expected to contain trace levels of the analytes of interest. Analysis that requires a solution or gas would need to have a pre-system capable of converting solid samples to the form necessary for analysis.

Some recent in-field debris analysis R&D has involved enabling LIBS and LIBS-like technologies since characteristic frequencies of a particular element can be induced which can be used to identify elements of interest. However, this technique is limited in its applicability in the post-detonation nuclear yield scenario because of its comparative nature (e.g. requires pre-knowledge of anticipated sample matrix). Therefore at this time Phase I proposals of this topic will not seek out to further the research in LIBS technologies or other technologies that require comparison to a known matrix or library. This call is looking for novel means to reduce the technical nuclear forensics timeline with technology such as rapid (<15 hours) debris dissolution techniques, quantitative techniques not requiring sample dissolution. Non-destructive or non-dissolution strategies must be capable of detecting ppb levels of impurities in an anticipated primary background of urban debris materials.

General requirements to be addressed are: identification of unique signatures of nuclear and non-nuclear materials for characterization, implementation of techniques to exploit these unique identifiers, and plans for integrating these novel techniques into a successful fieldable system.

PHASE I: 1) Identify existing or emerging technologies to identify and differentiate nuclear materials from non-nuclear materials. The identified technologies shall provide a rapid identification response and be capable of being integrated or packaged into a compact fieldable system. 2) Include concept(s) for a potential path forward for prototype design, test, evaluation, and fabrication.

PHASE II: Develop, test, demonstrate, and validate this prototype system under simulated post-detonation conditions and anticipated conduct of operations. Factors to be considered include if the system will act passively or actively, the likely background radiation surrounding the technology during anticipated conops, transmissibility of analysis results to analysts, etc. Cost and weight implications, reliability, and reproducibility shall also be addressed. Develop a production-scalable process and business plan to manufacture the system prototype.

PHASE III: DUAL USE APPLICATIONS: Successful product will support forensics-related and other Military first-responders in a post-detonation environment, in support of the National Technical Nuclear Forensics, consequence management, and response and recovery.

REFERENCES:
1) www.pnas.org/cgi/doi/10.1073/pnas.1010631107 and references therein.

KEYWORDS: Nuclear forensics, debris, nuclear detonation, field analysis, lab analysis, sample collection, sample analysis, attribution